

DISTRIBUTION OF *ANOPHELES SUNDAICUS* RODENW. THROUGH MECHANICAL MEANS.¹

BY

DR. P. SEN, M.Sc. (Cal.), Ph.D. (Lond.), D.I.C.,

Entomologist, Bengal Public Health Department, Calcutta.

(With a map).

Mechanical transport of insect pests from one country to another through sea-going vessels or country craft has been long known, and quarantine measures against several of such pests are in practice in almost all progressive countries. The list of pests thus accidentally introduced is very exhaustive. While these instances mostly relate to the agricultural and forest pests, mosquitoes making long distance journeys and passing from one country to another, in railway carriages are also on record (Howard, Dyar & Knab, 1912).

An example of dispersal of a more limited nature, inside the same country, is afforded by the species *Anopheles sundaicus* Rodenw., a virulent carrier of malaria, which, so far as the records go, was originally known in this province only from the coastal tracts such as the Sundarbans, the species being a saltwater breeder. In 1910 the range of the species was upto Matla and Port Canning about 30 miles away from Calcutta (Gravely 1912). In 1930, the species made a further push inland to Budge-Budge, only 16 miles from Calcutta (*vide* map attached), where a sudden malarial outbreak was experienced in the locality (Iyengar 1931).

Since then, the distribution of the species has been under constant investigation, and an explanation for the factors responsible for similar invasions towards inland areas has been sought for and a close watch has been kept on the vast marshy areas to the immediate east of Calcutta, the salt lakes, which apparently seem very suitable for the establishment of the species.

Constant vigilance led to the detection for the first time in 1931 of an instance of transport of the mosquito into this area by means of a country boat which entered the canal bordering the salt lakes and which had evidently passed *en route* through a *sundaicus* infested zone in the Sundarbans, (Sen 1938). After this discovery, systematic searches of boats and trains reaching Calcutta at different termini were carried out, and it soon became evident that the invasion of the species was taking place not only by boats through the canal but by trains and through other routes as well.

Trains from Falta (Kalighat Falta Railway), where the species was breeding profusely, on being searched at Majherat, the city

¹ Read before the 28th Session of the Indian Science Congress, 1941.

station of the railway, as also trains from Basirhat and Hasnabad (Barasat Basirhat Railway), another *sundaicus* zone, arriving at Shambazar (Calcutta) and certain local trains stopping overnight at Uluberia and Port Canning, some of the known *sundaicus* areas, on examination at Howrah (Bengal Nagpur Railway) and Sealdah South (Eastern Bengal Railway) showed the transport of adult *A. sunndaicus* by this means during the period June to August or September 1934 (Table I). The species was carried by trains to Howrah and Shambazar (both these stations being situated on the outskirts of Calcutta) during the month of November 1933, showing that the mosquito transport is possible in the cold weather as well. Besides *A. sunndaicus* the following Anophelines, not concerned in the transmission of malaria in the area involved, were also transported in the years 1933 and 1934 through trains: *A. hyrcanus*, *A. barbirostris*, *A. annularis*, *A. ramsayi*, *A. philippinensis*, *A. vagus*, *A. subpictus*, *A. varuna*, *A. aconitus* and *A. stephensi*.

TABLE I
*Transport in trains.*¹

Stations where trains were examined	Period of Investigation	No. of trains examined	No. of trains showing <i>A. sunndaicus</i>	No. of adult <i>A. sunndaicus</i> caught	Other species recorded
Majherat ...	August 1933	?	nil.	nil.	?
	September "	?	"	"	?
	October "	7	"	"	<i>A. vagus</i> , <i>A. annularis</i> , <i>A. hyrcanus</i> , <i>A. ramsayi</i> .
	November "	12	"	"	<i>A. barbirostris</i> , <i>A. hyrcanus</i> , <i>A. annularis</i> , <i>A. vagus</i> , <i>A. varuna</i> .
	December "	11	"	"	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. hyrcanus</i> , <i>A. philippinensis</i> .
	January 1934	7	"	"	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. hyrcanus</i> .
	February "	1	"	"	<i>A. vagus</i> .
	March "	3	"	"	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. hyrcanus</i> .
	April "	2	"	"	<i>A. vagus</i> .
	May "	1	"	"	<i>A. vagus</i> .
	June "	12	3	9	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. annularis</i> .
	July "	14	4	10	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. varuna</i> , <i>A. hyrcanus</i> , <i>A. ramsayi</i> .

¹ Detailed data from month to month are not available for Sealdah, and the station is therefore omitted from Table I.

TABLE I—(continued)

Stations where trains were examined	Period of Investigation	No. of trains examined	No. of trains showing <i>A. sundaicus</i>	No. of adult <i>A. sundaicus</i> caught	Other species recorded
Majherat ...	August 1934	16	1	1	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. varuna</i> , <i>A. aconitus</i> , <i>A. hyrcanus</i> , <i>A. ramsayi</i> .
	September „	10	nil.	nil.	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. hyrcanus</i> .
	October „	7	„	„	<i>A. vagus</i> , <i>A. hyrcanus</i> .
Shambazar.	November 1933	4	1	1	<i>A. vagus</i> , <i>A. annularis</i> , <i>A. hyrcanus</i> , <i>A. ramsayi</i> .
	December „	6	nil.	nil.	<i>A. annularis</i> , <i>A. hyrcanus</i> , <i>A. barbirostris</i> .
	January 1934	2	„	„	<i>A. subpictus</i> , <i>A. annularis</i> .
	February „	?	„	„	?
	March „	1	„	„	<i>A. subpictus</i> , <i>A. annularis</i> .
	April „	3	1	1	<i>A. vagus</i> .
	May „	1	nil.	nil.	<i>A. vagus</i> , <i>A. subpictus</i> .
	June „	7	3	26	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. annularis</i> .
	July „	8	6	25	<i>A. subpictus</i> , <i>A. vagus</i> .
	August „	8	4	12	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. annularis</i> , <i>A. hyrcanus</i> .
Howrah ...	September „	13	3	7	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. varuna</i> , <i>A. aconitus</i> , <i>A. hyrcanus</i> , <i>A. ramsayi</i> .
	August 1933	?	nil.	nil.	?
	September „	?	„	„	?
	October „	3	„	„	<i>A. hyrcanus</i> .
	November „	5	1	1	<i>A. vagus</i> , <i>A. annularis</i> , <i>A. hyrcanus</i> , <i>A. barbirostris</i> .
	December „	9	nil.	nil.	<i>A. vagus</i> , <i>A. annularis</i> , <i>A. hyrcanus</i> , <i>A. barbirostris</i> , <i>A. aconitus</i> .

TABLE I—(continued)

Stations where trains were examined	Period of Investigation	No. of trains examined	No. of trains showing <i>A. sundaeicus</i>	No. of adult <i>A. sundaeicus</i> caught	Other species recorded
Howrah ...	January 1934	2	nil.	nil.	<i>A. aconitus</i> .
	February "	5	"	"	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. annularis</i> , <i>A. varuna</i> , <i>A. hyrcanus</i> , <i>A. barbirostris</i> , <i>A. stephensi</i> .
	March "	10	"	"	<i>A. vagus</i> , <i>A. varuna</i> , <i>A. aconitus</i> , <i>A. hyrcanus</i> , <i>A. philippinensis</i> .
	April "	6	"	"	<i>A. vagus</i> , <i>A. annularis</i> , <i>A. varuna</i> , <i>A. aconitus</i> , <i>A. barbirostris</i> , <i>A. ramsayi</i> .
	May "	9	"	"	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. ramsayi</i> .
	June "	10	2	2	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. ramsayi</i> .
	July "	8	2	2	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. hyrcanus</i> , <i>A. barbirostris</i> .
	August "	8	4	4	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. hyrcanus</i> , <i>A. barbirostris</i> .
	September "	2	nil.	nil.	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. annularis</i> , <i>A. aconitus</i> , <i>A. hyrcanus</i> .
	October "	1	"	"	<i>A. vagus</i> .♂
Total ...		234	35	101	

Although 35 out of 234, or nearly 15 per cent, of the trains examined carried *A. sundaeicus*, it is however, believed that the transport through boats and not trains, has been really responsible for the ultimate establishment of the species during recent years in the Calcutta Salt Lakes area. The reason is that no trains stop anywhere close to the Salt Lakes proper and the species first started to breed in the Kristopur end of the lakes towards the end of December 1932, where, as already mentioned, infested boats (Fig. 1) were known to be arriving since 1931. Boats to Calcutta are sometimes detained overnight at Kristopur for the realisation of tolls. Moreover, there is ample evidence that active dispersal of the species occurred in 1933 and 1934 by means of boat traffic coming to Calcutta either through (1) the river Hooghly which is in direct line with the Sundarbans, or through (2) the river Ichamati which traverses some of the worst *sundaeicus* infested zones and to Kristopur Canal bordering the Calcutta Salt Lakes area as will be seen from Table II.

TABLE II

Transport in country boats.

Points where boats were examined	Period of Investigation	No. of boats examined	No. of boats showing <i>A. sundaicus</i>	No. of adult <i>A. sundaicus</i> caught	Other species recorded
Kulti-Lock.	July 1933	83	14	19	<i>A. subpictus</i> , <i>A. vagus</i> .
	Aug., Sept. and Oct. 1933	674	22	29	<i>A. subpictus</i> , <i>A. vagus</i> .
	Nov. and Dec. 1933	747	29	38	<i>A. subpictus</i> , <i>A. vagus</i> , <i>A. varuna</i> .
	Jan. and Feb. 1934	199	1	2	
	July, Aug. and Sept. 1934	284	31	41	<i>A. subpictus</i> , <i>A. vagus</i> .
	Oct., Nov. and Dec. 1934	238	23	?	
Kristopur Toll Office	Aug., Sept. and Oct. 1933	280	2	3	<i>A. subpictus</i> , <i>A. vagus</i> .
	Nov. and Dec. 1934	256	5		
Chitpur-Lock	February and March 1934	65	nil.	nil.	
Canning Town	December 1933	206	9	10	
	January and February 1934	30	nil.	nil.	
Total...		3,062	136	142	

It has been found from observations covering a period of one year and a half, i.e., from July 1933 to December 1934, that 136 boats out of 3062 examined, i.e. over 4 per cent, coming up the different routes to Calcutta, were serving as transporting agencies of *A. sundaicus*. Three other species—*A. subpictus*, *A. vagus*, and *A. varuna*—were also sheltering in the country boats; these three species are however ubiquitous in distribution and of no importance from the malarial point of view in the area.

Of the various types of cargo carried in the country boats sheltering *A. sundaicus*, such as paddy (rice), jute, straw, sugar, molasses, salt, pulses, wood, ginger, garlic, kerosene, matches, nut, banana, goats, fowl, earthen pots, etc., paddy, jute and straw appear to provide a favourable resting place for the species.

The forward and upward thrust of the species to range beyond its original boundary is thought to be due to the extensive clearance of mangrove forests in the Sundarbans and the reclamation of lands for rice cultivation and fishery purposes, thereby creating

conditions for an excessive rise in the insect population. Secondly easier and quicker communications during recent years have provided more advantageous means of safe dispersal of the species into inland areas. Some unaccountable meteorological factors existing some time about the year 1930, the year of *A. sundaicus* invasion to Budge-Budge, as pointed out by Covell (1932), may also be largely responsible for their recent dispersal towards inland areas.

SUMMARY.

Mechanical transport of *Anopheles sundaicus* through trains and country boats during the years 1933 and 1934 is recorded.

Catches made from carriages at the terminal stations of the different railways in Calcutta, having train connections with the out-lying *sundaicus* zones in the delta, showed that in addition to *A. sundaicus*, several other species such as *A. hyrcanus*, *A. barbirostris*, *A. annularis*, *A. ramsayi*, *A. philippinensis*, *A. vagus*, *A. subpictus*, *A. varuna*, *A. aconitus*, and *A. stephensi* are also mechanically transported into the city.

Country boats passing through the *Sundarbans* and other *sundaicus* infested areas on arrival at Calcutta by different routes revealed the presence of *A. sundaicus* under shelter of the cargo. Along with *A. sundaicus*, the species *A. subpictus*, *A. vagus*, and *A. varuna* were also dispersed through these boats.

Nearly 15 per cent of the trains examined carried *A. sundaicus*, while about 4 per cent of the country boats examined were responsible for the spread of the species. The dispersal of the species by means of trains was more noticeable from June to September and by country boats during the last six months of the year, July to December.

It is thought that the eventual establishment of *A. sundaicus* in the Salt Lake area to the east of Calcutta has been the outcome of mechanical importation of the species through the agency of country boats.

REFERENCES.

Covell, G. (1932).—Malaria in Calcutta. Bengal Secretariat Book Depot, Calcutta, p. 39.

Gravely, F. H. (1912).—Malaria mortality in the fringe area of Calcutta. *Rec. Ind. Mus.* vii, p. 309.

Howard, L. O., Dyar, H. G. & Knab, F. (1912).—The mosquitoes of North and Central America and the West Indies. Volume One. Carnegie Inst. Washington, pp. 345-352.

Iyengar, M. O. T. (1931).—The distribution of *Anopheles ludlowii* in Bengal and its importance in malarial epidemiology. *Ind. Journ. Med. Res.* xix, pp. 504-508.

Sen, P. (1938).—*Anopheles ludlowii* (*A. sundaicus*) survey in and around Calcutta. *Proc. Nat. Inst. Sc. India*, iv, 2, p. 233.